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Cognitive Correlates of Reading and Spelling Patterns: An Analysis of Boder's Method of Subtyping Disabled Readers

Richard Conte, Marilyn Samuels, and Harry Zirk
The Learning Centre
Calgary, Alberta

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Abstract

The Boder and Jarrico subtyping methodology is based on the notion that there are two fundamental subclasses of reading difficulty. One is related to phonic analysis; the other to visual-spatial memory. They have developed a set of measures which are allegedly sensitive to these two types of reading-related cognitive deficits. These include a sight word reading test, a sight word spelling test, and a spelling test which makes use of words not in the sight vocabulary. They subclassify readers by examining the level of performance across these three criterion measures.

The purpose of the present study was to examine the validity of the Boder and Jarrico test procedures. Specifically, it was hypothesized that the Boder and Jarrico criterion measures should be sensitive to two cognitive functions: knowledge of letter-sound correspondences, and visual-spatial memory. A regression model was employed in which measures of these two functions were used to predict performance on the Boder and Jarrico criterion tests.

In the total group which was comprised of both normal and disabled readers, knowledge of letter-sound correspondences was the best predictor of all three criterion measures. There was little evidence of a visual-memory component in any of the Boder and Jarrico tasks. The same conclusion was arrived at in the analysis of the disabled readers only. The visual memory component only emerged in the analysis of the spelling performance of two subgroups of subjects who differed in their knowledge of phonics. In the group with above average phonic skills, knowledge of letter-sound correspondences was the best predictor of their ability to produce phonetically accurate spellings. In the group with below average phonics, visual-spatial memory was the best predictor. These findings suggested that the interpretation of the Boder and Jarrico criterion measures is dependent on the skills of the reader; i.e., the ability to produce phonetically accurate spellings appears to be a reflection of knowledge of letter-sound correspondences in subjects with good phonic skills, but it may be provide an index of some other function such as visual-memory in children with below average phonic skills.

Finally, there was evidence of an age-related bias in the ability to produce phonetically accurate spellings. Older subjects produced more such spellings than younger subjects, presumably because the older readers have had more practice using phonics. This finding was considered significant because the ability to produce phonetically accurate spellings is the measure which is given the most weight in distinguishing the subtypes. It also suggested that achievement (as opposed to cognitive deficit) may play an important role in determining the outcome of this test.

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Ms. Pat Gillespie: Calgary Board of Education (1981-82).

Dr. Neil Hutton: Calgary Society for Students with Learning Difficulties (1980-82).

Ms. Jean van der Lee: Calgary Board of Education (1980-81).

Dr. Harry Sherk: Planning Services Branch, Alberta Education (1980-83).

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Cognitive Correlates of Reading and Spelling Patterns: An Analysis of Boder and Jarrico's Method of Subtyping Disabled Readers

Richard Conte, Marilyn Samuels and Harry Zirk
The Learning Centre
Calgary, Alberta

I. Introduction

One of the more widely accepted views in the current literature is that there are two general subcategories of reading disability. In this view (Myklebust, 1965; Boder, 1971), some reading difficulties are due to deficits in auditory-linguistic processing skills, while others are caused by an inability to process visual-spatial information. It is also suggested that readers in these subtyping categories present very different types of reading difficulties. For example, those in the auditory-linguistic group find it difficult to analyze a word into its constituent phonemes. This difficulty would be especially apparent when unfamiliar words were presented because the reader would not have the requisite skills to break down the word into its pronounceable components. An individual with this type of reading problem could learn to read only by associating the sound of the whole word with its visual representation. In this paper this method of reading will be referred to as the "whole word" or "visual" approach.

In contrast, the reader with a visually based reading problem would have little difficulty learning new words, since phonic skills would be adequate. Instead, this reader's problem would appear as an inability to read fluently. In the absence of good visual memory skills, words could be read only by means of phonic analysis, and thus, word decoding would not become sufficiently automatic to achieve the fluency which is characteristic of the mature reader. We will refer to this method of reading as the "phonic" or "auditory-linguistic" approach.

A logical extension of subtyping is that the method of remediation must be geared to the type of reading problem presented. Thus, some theorists advocate using tactile approaches to compensate for deficient visual memory skills, or a remedial phonics program to help those with deficient phonics. For this individualized approach to be implemented, there must be reliable methods available to identify each of the subtypes. While a number of identification approaches have been reported in the research literature (Mattis, French and Rapin, 1975; Satz and Morris, 1981), none of them can be applied readily in the clinical setting because they involve the administration of a large number of tests, and/or require complex statistical manipulations of the data.

Boder and Jarrico (1982) have recently published a test, based on earlier work (Boder, 1971, 1973), which is designed to assess the cognitive deficits underlying reading disabilities. Unlike other current subtyping methodologies, this test has been designed for use in the clinical setting.

Boder and Jarrico claim that the two basic reader subtypes described above (with several variants) may be derived from this test: a reading disability related to an auditory-linguistic deficit (which Boder and Jarrico call the dysphonetic subtype), and a reading disability related to a visual-spatial deficit (which they label the dyseidetic subtype). In this method, subtyping is achieved by analysis of three measures of reading and spelling performance which are presumably sensitive to the visual-spatial and verbal deficits found in the subtypes. The focus of the present investigation was to examine the validity of the inferences derived from the Boder and Jarrico reading and spelling measures.

A. Description of the Boder and Jarrico Subtyping Methodology

There are two dimensions which provide the basis of the Boder and Jarrico subtyping methodology: the dyslexic/non-dyslexic dimension and the dimension of dyslexic subgroups.

1. The Dyslexic/Non-dyslexic Dimension

In the terminology used by Boder and Jarrico, dyslexia refers to a reading disability related to a cognitive deficiency. This may be distinguished from a reading disability caused by what they term non-specific factors (e.g., inadequate exposure to reading material).

Boder and Jarrico argue that there are two cognitive deficits which characterize dyslexics: an inability to read words as whole patterns or gestalts and an inability to revisualize words in the sight vocabulary. The first deficit is defined in terms of reading quotient (RQ), and it is assessed by having the examinee read graded word lists. In order to insure that the test measures the ability to read words as whole patterns, credit is given only for those words read within one second of presentation. The highest grade level word list which can be read determines the examinee's reading grade.

Reading quotient (RQ) is calculated by applying the following formula:

$$RQ=reading\ grade/expected\ reading\ grade) * 100$$

By definition, dyslexics generally have a reading quotient less than 100. For dysphonetics it must be above 67 while for dyseidetics it must be below 80.

The second cognitive deficit which characterizes dyslexics is measured with a test of the ability to spell words in the sight vocabulary. After the sight word reading test has been completed, the examiner selects ten words (5 phonetic and 5 non-phonetic) that were read correctly and asks the examinee to spell them. The "Known

Correct" score is the percentage of these words spelled correctly. As indicated in the criteria in Table I, most dyslexic readers can correctly spell only 50% or fewer of the words in the sight vocabulary. The criterion value for both dysphonetics and dyseidetics is a score of 50% or less. Note, however, that in the criteria for the dysphonetic "variant", the Known Correct may be above 50%.

2. The Dimension of Dyslexic Subtypes

According to Boder and Jarrico, nearly all dyslexic readers have a reading quotient of less than 100 and can spell at most 50% of the words in the sight vocabulary. The measure which differentiates the disabled reader subtypes is the ability to produce good phonetic equivalents (GFE's) when spelling words which are not in the sight word vocabulary.

In this part of the test the examiner selects ten words (5 phonetic and 5 non-phonetic) which were read incorrectly and asks the examinee to spell them. The GFE score is the percentage of words which are spelled as phonetic equivalents of the words. Boder and Jarrico have developed detailed rules for scoring words as GFE's. According to the criteria published in the test manual, dyseidetics produce more than 50% GFE's; dysphonetics produce 50% or fewer GFE's. The criteria for the other subtypes are given in Table 1. According to Boder and

TABLE I
SUBTYPING CRITERIA

	Reading Quotient	GFE	Known Correct
Normal	gt 100	gt 50%	gt 50%
Non-Specific	lt 100	gt 50%	gt 50%
Dysphonetic	gt 67	le 50%	le 50%
Dysphonetic Variant	gt 67	le 50%	gt 50%
Dyseidetic	lt 80	gt 50%	le 50%
Mixed	lt 67	le 50%	le 50%
Mixed Variant	lt 67	le 50%	gt 50%
Undetermined	gt 80	gt 50%	le 50%

Abbreviations

gt: greater than
lt: less than
le: less than or equal to

Jarrico, the GFE score is a measure of phonic word analysis skills.

B. Literature Review

Most previous studies which have investigated the validity of the Boder subtyping measures have focused on the cognitive abilities of the two major Boder subtypes: dysphonetics and dyseidetics. The theory underlying Boder and Jarrico's subtyping methodology makes straightforward predictions regarding the performance of these groups: dysphonetics should have difficulty on tasks which involve the processing of verbal information; dyseidetics should be impaired on visual-spatial tasks.

The evidence supporting deficient verbal skills in dysphonetics is quite consistent across studies. For example, it has been found that dysphonetics have significantly lower WISC-R verbal than performance scores (Ginn, 1979); they have difficulty discriminating phonemes embedded in time-compressed speech (Menken, 1981); and they show an abnormal pattern of cerebral lateralization of language functions (Dalby and Gibson, 1981; Malatesha, 1981). Also, patterns of cerebral electrical activity indicate abnormal lateralization of language functions in dysphonetics (Fried, Tanguay, Boder, Doubleday and Greensite, 1981). On the other hand, there is little evidence supporting the notion of deficient visual-spatial skills in dyseidetics. Ginn (1979) and Dalby and Gibson

(1981) found no difference between the WISC-R verbal and performance scores of dyseidetics. Also, Dalby and Gibson found only abnormal cerebral lateralization of verbal skills in dyseidetics, but essentially normal lateralization of visual spatial skills. Fried et al., (1981) showed that dyseidetics had a normal pattern with respect to the lateralization of cerebral electrical activity. In his analysis of visual-spatial skills, Aaron (1978) found that dyseidetics and normals both showed the same pattern of performance on a task which assessed preferences for holistic vs analytic processing of complex visual stimuli. In contrast, dysphonetics showed a marked preference for holistic processing. The only evidence suggesting deficient visual-spatial skills in dyseidetics was Aaron's finding that dyseidetics showed a lower level of performance than dysphonetics or normals on a face recognition task.

The lack of evidence for a visual-spatial processing deficit in dyseidetics could mean that some of the fundamental assumptions of the Boder and Jarrico subtyping method are invalid. Consider the criteria used to classify disabled readers. The only measure which is used to distinguish dysphonetics from dyseidetics is the percent GFE's: dysphonetics produce few GFE's while dyseidetics produce as many as normals. The ability to process visual information does not play a role in differentiating dysphonetics and dyseidetics, unless one assumes that dyseidetics must have poorer visual-spatial skills because they have better verbal skills. The two measures which are supposed to provide information on visual-spatial functioning, RQ and Known Correct, are not used to differentiate the subtypes. In fact, with respect to these two measures the criteria for dysphonetics and dyseidetics are nearly identical. In the general case the RQ for dysphonetics must be above 67, and for dyseidetics below 80; i.e., there is considerable room for overlap. The Known Correct criterion value is the same for both groups; i.e., it must be 50% or less. Therefore, not only is there a lack of evidence to support a visual-spatial deficit in dyseidetics, but also there is no compelling logic to support this conclusion.

C. Experimental Questions

Given the lack of evidence to support a visual-spatial deficit in dyseidetics, it may be that the criteria used by Boder and Jarrico need modification. Before this can be done, some fundamental questions need to be answered concerning the criterion measures they used. Rather than examining the cognitive abilities of readers in the different subtypes as has been done in previous work (Ginn, 1979; Menken, 1981), the focus of the present study was on the cognitive significance of the measures which are used to define the subtypes: RQ, Known Correct and GFE. In making this assessment the cognitive functions considered were those which Boder and Jarrico suggest differentiate dysphonetics and dyseidetics: knowledge of phonics, and visual-spatial memory. A regression model was used in which measures of phonics and visual-spatial memory were predictors in the regression equation and one of the Boder and Jarrico criterion measures was the dependent variable. This assessment was made in two different ways. First, the regression equations were computed for the total sample which was composed of both disabled and normal readers. It was also performed for the disabled readers alone. There were no comparisons made of the normal and disabled readers since the focus of the investigation was on the significance of the measures, not on their capability to differentiate normal and disabled readers.

The intent of the second question was to determine if the cognitive significance of the criterion measures is the same for all examinees or if it is dependent on the skill level of the examinee. In this case the regression analysis was performed for two groups who differed in the ability to produce GFE's (a High GFE group and a Low GFE group). GFE's were the focus of attention since this is the measure which is used to distinguish dysphonetics and dyseidetics.

The third question concerned the extent to which the age and/or experience of the examinee's may affect the way they are classified. If the test provides a measure of cognitive deficit, then it should not be affected by the age and experience of the examinees. To answer this question, a developmental analysis was conducted in which subjects were classified into young and old age groups. The percent GFE's produced in each of the groups was compared.

1. What is the Cognitive Significance of the Boder and Jarrico Criterion Measures? (Total Group Analysis)

a. Reading Quotient and Known Correct

These two measures are discussed together because, according to Boder and Jarrico, they represent similar cognitive functions. Reading quotient is said to provide an index of memory for whole word patterns and Known Correct is purported to be a measure of the ability to revisualize words in the sight vocabulary. In other words, both are supposed to provide an index of visual memory.

Recall that the RQ is derived from the examinee's ability to read isolated words within one second of presentation. On Boder and Jarrico's assumption that a phonic approach is not used, the examinee must recognize the visual pattern, retrieve the speech pattern, and reproduce it. The Known Correct score is derived from the ability to spell words in the sight vocabulary. Again, assuming that phonic analysis is not used, the examinee must be able to recognize an auditory representation of the word, retrieve the appropriate graphic pattern and reproduce it. Even though there are many information processing steps in performing these tasks, Boder and Jarrico conceptualize them as being indices of visual/gestalt or holistic processing.

An obvious alternative possibility is that examinees perform some type of phonic analysis in performing these tasks. Even though 1/2 of the words in the sight list and in the spelling tests are irregular or non-phonetic, knowledge of phonics could still be important in performing these tasks. Further, there is no guarantee that subjects cannot use a phonic approach when reading the sight word lists because a one second deadline is imposed.

A third possibility is that there is no single strategy employed by all readers and that the approach taken depends on the pattern of skills of the individual. Thus, those who have a good knowledge of phonics might perform phonic analysis, whereas those who have strong visual-spatial skills might rely more heavily on visual memory.

The fundamental distinction which is being made here is that when reading a list of sight words, examinees potentially have two strategies available. On the one hand if they use a phonic or analytic strategy (to use Boder and Jarrico's terminology), they would analyze a word into its component parts, retrieve the corresponding sound for each component, put the components together, and then say the word. Alternatively, if they used a whole word or visual strategy, they would go directly from the whole visual pattern to the whole sound pattern. When spelling known words, the same two strategies are available, but the sequence is reversed because in this case examinees are given the auditory pattern and must produce the graphic image. In terms of the analytic strategy they would break down the sound of the word into its components, find the letter symbol that corresponded to each sound, and then write out the letters. If they used a more holistic strategy, then they would go directly from the sound pattern to the visual representation of the word. In order to use either of these strategies there are two requirements: the examinee must possess the component skills and must be able and willing to use the skills.

One of the skills (among others) required for the holistic strategy is the ability to access visual memory. The requirement for the analytic strategy is knowledge of and the ability to use letter-sound correspondences. In the present study these two strategies were contrasted by using a letter sequencing memory task described by Samuels, Hiscock and Kinsbourne (1978). In this task, the examinee is presented with a set of 24 letters in a 6 x 4 matrix. On each trial the examiner points to a subset of letters in the matrix. After removing the letters from sight, the examiner presents the board again, and the examinee is required to point at the original stimulus items. Three conditions were used by Samuels et al. First, in the letter- no-change (LNC) condition the matrix presented at recall was identical to that initially presented; i.e., the letters were in the same spatial position. Second, in the letter-change (LC) condition the same set of letters as used at the time of recall was presented, but their spatial position in the matrix was changed. Finally, in the letter-dot (LD) condition, the matrix presented at the time of retrieval was filled with dots instead of letters and the examinee was required to point to the matrix cells which had been pointed to by the examiner.

Samuels et al. argued that this task provides information on two skills: positional (visual-spatial) memory and the ability to use verbal mnemonics. The LC condition is a measure of subjects' use of verbal mnemonic's, because in the absence of any spatial cues, the most efficient strategy is to remember the letter names. The LD condition is a measure of visual memory because the letters were not present in the response matrix and the examinee had to retain the spatial information. The normal developmental progression across three age groups found by Samuels et al. (1978) was that performance in the LC condition improved with age, whereas performance in the LD condition did not. In the present work the LC and LD conditions of this task were used to provide an index of subjects' ability to employ visual-spatial vs. verbal-mnemonic strategy.

In the present work it was hypothesized that there was considerable overlap between the skills used in phonic analysis and those used in the LC condition of the letter sequencing task because letter-sound correspondences need to be utilized in both of them. This was verified by comparing the scores obtained in the LC condition with a more conventional measure of phonics, The Word Attack Subtest of the Woodcock Reading Mastery Test. It was also assumed that the LD condition would be more closely related to visual- gestalt or holistic processing because the only obvious strategy to be used on this task was visual memory.

It was hypothesized that if the Known correct and RQ are indices of visual-spatial processing skills (as suggested by Boder and Jarrico), then performance on each of these tasks should be more closely related to the LD condition than to the LC condition of the letter sequencing task, on the assumption that the LC task does not measure visual-memory skill. Alternatively, if examinees are using letter-sound correspondences (as in phonic analysis) in performing these tasks, then the performance in the LC condition would be the best predictor of performance.

b. GFE

GFE is the primary measure used to differentiate dysphonetics and dyseidetics. Previous evidence has indicated that dysphonetics have below average verbal skills as indicated by WISC-R scores (Ginn, 1979), performance on phoneme discrimination tasks (Menken, 1981), and by the fact that they show a pattern of cerebral lateralization of language functions similar to language disordered children (Malatesha, 1981). All these studies suggest some type of verbal deficit in dysphonetics. However, Boder and Jarrico use these studies as evidence of a deficit in verbal-analytic processing. In the context of their test this would mean a lack of knowledge of letter-sound correspondences and an inability to perform phonic analysis. As yet, no study has compared the results of the Boder and Jarrico test with a more conventional measure of phonics. This was done in the present work by computing correlations between the GFE score (the primary measure of phonics) with performance on the Word Attack subtest of the Woodcock Reading Mastery Test. Note that the Word Attack subtest assesses phonic skill while subjects attempt to read nonsense words, whereas in the Boder and Jarrico test phonics is assessed as subjects attempt to spell words not in the sight vocabulary. Two predictions were made in the present study. First, it was hypothesized that there would be significant correlations between the GFE score and the score obtained from the Word Attack Subtest. Second, compared to the LD condition, the LC condition of the letter sequencing task should be more closely related to the GFE score.

2. Is the Cognitive Significance of the Measures Dependent on Reader Skill?

There is a tacit assumption in the Boder and Jarrico methodology that all readers use the same strategy when performing the reading and spelling tasks. For example, if an examinee produces relatively few GFE's, it is concluded that this reader is dysphonetic; i.e., has a cognitive deficit which precludes learning phonics. The reader who produces many GFE's has no such cognitive deficit. In other words examinees who produce few GFE's either do not know the rules of phonics or cannot apply them. Those who produce many GFE's know how to apply these rules. In either case, the knowledge of phonics should be the principal determinant of the percent GFE's produced.

An alternative possiblity is that subjects who produce few GFE's use an inappropriate strategy; i.e., instead of using a phonic strategy, they use a less efficient approach. The alternative strategy considered in the present work was that of visual-memory, since this is usually considered an important component in skilled reading. If the type of strategy used is the factor which differentiates subjects who can and cannot use phonic rules, then one should find that in subjects who produce a high number of GFE's, a measure of phonics would be the best predictor of performance. For subjects who produce few GFE's, visual memory performance would be the best predictor.

In the present analysis subjects were divided into two groups: those who produced more than 50% GFE's (High GFE) and those who produced 50% or fewer GFE's (Low GFE). A regression analysis was conducted separately for each group in which measures of phonics, visual memory and the measure of verbal mnemonic strategy use were the independent variables and percent GFE was the criterion variable. If both groups tend to use a phonic approach when spelling words they can't read, then the measure of phonics should predict GFE's in both groups. If the groups use different strategies, then it was hypothesized that phonics would predict GFE's in the High GFE group, whereas visual memory performance would predict it in the Low GFE group.

3. Is Subtyping Age-Dependent?

One other feature of the Boder subtyping methodology is that the two principal subtyping measures, Known Correct and GFE's, are not adjusted for age; i.e., raw scores are used to determine reader subtype. One of the potential problems inherent in this procedure is that both scores might be expected to increase as a function of age.

Undoubtedly, even the most severely disabled readers learn more phonics as they grow older. Consequently, there should be fewer dysphonetics with increasing age. This prediction was confirmed in a recent study by Paul (1981) who found that in a sample of adolescent disabled readers, the majority were dyseidetic. In a review of previous studies of younger readers, Boder and Jarrico (1982) reported that only 9-20% were dyseidetic.

To answer this question, correlations were computed between age and the two Boder and Jarrico criterion measures which are not age-adjusted: GFE and Known Correct. Assuming that performance on these tasks improve with age, it was hypothesized that significant positive correlations would be obtained for GFE and Known Correct. In addition, subjects were divided into two groups, young and old, by means of a median split of age. An analysis of variance was used to compare the number of GFE's produced in the young and old age groups. It was hypothesized that GFE scores would be significantly higher in the older subjects.

II. Methodology

A. Subjects: Forty-eight subjects between the ages of 7 and 13 years were tested. Of these, 28 were disabled readers and 20 were normal readers. The disabled readers were children of average intelligence who had been referred to the Learning Centre for a specific learning disability in the area of reading. The normal readers were volunteers drawn from regular classrooms in the Calgary Board of Education. They were selected on the basis of a teacher report of no delay in reading.

B. Procedure: The subjects were tested in two one-hour sessions with a battery of tests which included: reading, phonics, and the letter sequencing memory task.

1. Reading Tests:

a. The Boder Test of Reading and Spelling Patterns

This test consists of three parts. First, a sight word reading test is given in which examinees read graded word lists. Credit is given only to those words read within one second of presentation. Second, examinees are required to spell 10 words (5 phonetic and 5 non-phonetic) which are in the sight vocabulary; i.e., were read within one second of presentation during the sight word reading test. This measure is referred to as the percent Known Correct. Third, examinees must spell 10 words (5 phonetic and 5 non-phonetic) which are not in the sight vocabulary. These spellings are scored as good phonetic equivalents (GFE's).

b. The Word Attack Subtest of the Woodcock Reading Mastery Test

This is a standardized test of phonics in which examinees must read pronounceable nonsense words.

2. Measures of Visual Memory and Verbal Mnemonic Strategy Use

The task used was derived from Samuels, Hiscock and Kinsbourne (1978). The examinee was presented with a set of 24 letters presented in a 6 x 4 matrix. Each cell contained a different letter of the alphabet. On each trial the examiner pointed to a subset of the letters (either 3,4 or 5 letters were used) at the rate of one second per letter. After each item was tapped once, the letters were removed from sight for five seconds. After this interval, the board was presented again and the examinee was required to indicate, by pointing, which stimulus items had been tapped by the examiner. There were three conditions in this experiment. First, in the letter-no-change (LNC) condition, the matrix presented at recall was identical to that initially presented; i.e., the letters were in the same spatial position in the matrix. For the letter-change (LC) condition the same set of letters was used, but the spatial position of the letters in the matrix was changed (randomly). Finally, in the letter-dot (LD) condition, the matrix presented at the time of retrieval was filled with dots instead of letters and the examinee was required to recall the matrix cells which had been pointed to by the examiner.

III. Results

A. Composition of the Sample of Examinees

I.Q. scores were not available for all subjects; however, a measure of receptive vocabulary (The Peabody Picture Vocabulary Test) indicated no significant difference (F 1,46=.22, p>.4) between children in the normal group who were 1.6 months (s.d.=12.28) above chronological age (C.A.), and the disabled readers who were 1.07 months (s.d.=23.1) below C.A. The average age of the disabled readers (10.8 years, s.d=1.9) differed significantly (F 1,46=9.7, p<.01) from that of the normal readers (9.1 years, s.d.=1.6). According to a sight word reading test (The Boder Test of Reading and Spelling Patterns), the normal readers were 1.98 years (s.d.=1.5) above C.A., whereas the disabled readers were 2.24 years (s.d.=1.71) below age level. Even though the disabled readers were older (in terms of C.A.) than the normal readers, the Reading Age of the normals (11.16 years, s.d.=2.5) was significantly (F 1,46=10.81, p<.01) higher than that of the disabled group (8.58 years, s.d.=2.6 years).

Analysis of the family backgrounds of the normal and disabled readers indicated that they came from predominantly middle class families: 45% of the disabled readers and 37% of the normal readers were the offspring of fathers who were in professional or managerial positions.

B. Validation of the Relationship Between the LC Condition of the Letter Sequencing Task and the Word Attack Test

One of the assumptions made in performing this study was that the information processing requirements of the LC condition of the letter sequencing task were similar to those utilized during phonic analysis. It was also assumed that there was no such similarity between the LD condition and phonic analysis. To test this assumption, the relevant correlations were computed for the total group of subjects. A highly significant correlation was obtained between the LC condition and the Word Attack grade score ($r=.504$, $p<.01$), while the correlation between LD and Word Attack grade score ($r=.079$) was non-significant ($p>.1$). For the group of disabled readers similar findings were obtained: The correlation between Word Attack and LC was .511 ($p<.01$), whereas that between Word Attack and LD was .18 ($p>.1$).

C. Correlations Among RQ, GFE, and Known Correct

A second assumption in performing this study was that each of the Boder and Jarrico criterion measures provides information on a unique aspect of cognitive functioning, and as such the measures should be relatively uncorrelated. In this analysis and in most subsequent analyses, Reading Age was used instead of RQ, because two of the other measures used in these analyses are age scores: chronological age and the Word Attack. Examination of the intercorrelations indicated a highly significant correlation between Reading Age and percent GFE ($r=.47$, $p<.01$), but considerably smaller correlations between Reading Age and Known Correct ($r=.33$, $p<.05$) and GFE and Known Correct ($r=.29$, $p<.05$). Although the correlations were all significant, there was still a substantial amount of variance unexplained; i.e., Reading Age accounted for only 22% of the variance in GFE, and only 9% of the variance in Known Correct.

D. Obtained Boder Subtypes

The examinees were classified into subtypes using the procedures specified by Boder and Jarrico. The results are shown separately for normal and disabled readers in Table 2. The labels, normal and disabled on the left of the Table refer to teacher-selected categories. The names across the top are Boder and Jarrico subtypes.

Only 12 of the 20 teacher selected normal readers were also subtyped normal, while 27 out 28 disabled readers were classified into disabled reader subtypes. Note that 12 of 13 examinees subtyped as normal, were also teacher-selected normal readers. Also, 12 of the 13 non-specific readers were teacher selected disabled readers. The most anomalous finding was that 6 of the dysphonetics were teacher-selected normals and 6 were teacher-selected disabled readers.

TABLE 2

DISTRIBUTION OF THE SUBTYPES IN NORMAL AND DISABLED READERS

	Normal	Non-specific	Dysphon.	Dyseid	Mixed	Undet.
Normal	12	1	6	0	0	1
Disabled	1	12	6	3	4	2

E. Regression Analyses for the Total Sample

In this analysis of the data, the relationships among measures of phonics, letter sequencing performance, and the three Boder criterion measures (Reading Age, GFE, and Known Correct) were explored. The general method of analysis was to use chronological age (C.A.), Word Attack age score, and the percent correct in the LD and LC conditions of the letter sequencing task as predictors in the multiple regression analysis and one of the Boder and Jarrico measures as the criterion variable. Two analyses are presented for each of the Boder and Jarrico criterion measures. The first is for the total group of 48 (normal and disabled) readers. The second included only the 28 disabled readers.

1. Reading Age

In the first analysis, chronological age, Word Attack age score, and the percent correct in the LC and LD conditions of the letter sequencing task were used as predictors, and Reading Age was the dependent variable in the regression analysis.

The results of this analysis indicated that Word Attack and LC condition of the letter sequencing task accounted for a significant amount of the variation in the Reading Age score (F 2,46=43.44); i.e., 60.% (p<.01) for Word Attack and 4.9% (p<.05) for LC.

The correlation matrix giving the relationships between the measures used in this analysis are shown in Table 3. There were highly significant correlations between Word Attack and Reading Age (r=.777, p<.01), and between LC and Reading Age (r=.58, p<.01). The correlation between LD and Reading Age was non-significant (r=.16).

The same analysis was repeated for the disabled readers. In this case Word Attack and C.A. accounted for significant (F 2,25=35.19) variance in Reading Age (61%, p<.01 and 12%, p<.05, respectively). Intercorrelations presented in Table 4 show that C.A., Word Attack and LC were strongly related (r=.77, .78 and .63, respectively) to Reading Age (all p values less than .01) The correlation between LD and Reading Age was not significant (r=.32, p>.1).

2. Known Correct.

In this analysis chronological age, the Word Attack age score, and the percent correct in the LD and LC conditions were used as predictors, and percent Known Correct was the dependent variable. It was found that Word Attack was significantly related to the Known Correct score (F 1,46=7.16). It accounted for 14% (p<.05) of the variance.

The correlation matrix shown in Table 5 indicates that Word Attack and LC were similarly related to Known Correct (r=.376, p<.05 and r=.375, p<.05, respectively). The fact that the regression analysis was significant only for Word Attack suggests that there was considerable shared variance

TABLE 3

CORRELATION MATRIX FOR READING AGE IN THE TOTAL SAMPLE (N=48)

	CA	Reading Age	LC	LD	Word Attack
CA	1.00				
Reading Age	.32	1.00			
LC	.53	.58	1.00		
LD	.48	.16	.36	1.00	
Word Attack	.34	.78	.50	.07	1.00

Abbreviations

CA: Chronological Age

LC: Letter-Change Condition

LD: Letter-Dot Condition

TABLE 4

CORRELATION MATRIX FOR READING AGE IN THE DISABLED READERS (N=28)

	CA	Reading Age	LC	LD	Word Attack
CA	1.00				
Reading Age	.77	1.00			
LC	.69	.64	1.00		
LD	.49	.32	.46	1.00	
Word Attack	.63	.78	.51	.18	1.00

Abbreviations

CA: Chronological Age
LC: Letter-Change Condition
LD: Letter-Dot Condition

TABLE 5

CORRELATION MATRIX FOR KNOWN CORRECT IN THE TOTAL SAMPLE (N=48)

	CA	Known Correct	LC	LD	Word Attack
CA	1.00				
Known Correct	.16	1.00			
LC	.53	.37	1.00		
LD	.49	.08	.36	1.00	
Word Attack	.34	.38	.50	.08	1.00

Abbreviations

CA: Chronological Age
LC: Letter-Change Condition
LD: Letter-Dot Condition

between the two measures. On the other hand the correlation between LD and Known Correct was considerably lower (r=.08).

For the disabled readers LC accounted for 18% (p <.05) of the variance in the Known Correct score (F 1,26=5.80). As shown in Table 6, the correlation between LC and Known Correct was .42, P<.05. The correlations for Word Attack and LD were both non-significant (r=.31 and .29).

3. Percent Good Phonetic Equivalents

For this analysis the same set of predictors was used as in the previous analysis, and the percent GFE was the dependent variable. Word attack and the LC condition were significantly related to GFE (F 2,45=19.29). Word Attack accounted for 38% (p,>01) of the variance and the LC condition accounted for only 7% (p<.05) of the variance.

The correlation matrix is shown in Table 7, and it indicates that the magnitude of the correlations for Word Attack and LC (with GFE) were roughly equal (r=.62, p<.01 and .54, p<.01), whereas that for LD and GFE was considerably lower (r=.29, p<.05).

For the disabled group LC and Word Attack both accounted for significant variance in GFE (F 2,25=15.79). LC accounted for 46.9% (p<.01) of the variance and Word Attack 8.8% (p<.05). The correlation matrix (Table 8) shows that the correlations for LC (.68, p<.01) and Word Attack (.60, p<.01) were considerably higher than that

TABLE 6

CORRELATION MATRIX FOR KNOWN CORRECT IN DISABLED READERS (N=28)

	CA	Known Correct	LC	LD	Word Attack
CA	1.00				
Known Correct	.41	1.00			
LC	.69	.43	1.00		
LD	.49	.29	.46	1.00	
Word Attack	.63	.31	.51	.18	1.00

Abbreviations

CA: Chronological Age
LC: Letter-Change Condition
LD: Letter-Dot Condition

TABLE 7

CORRELATION MATRIX FOR PERCENT GFE'S FOR THE TOTAL SAMPLE (N=48)

	CA	GFE	LC	LD	Word Attack
CA	1.00				
GFE	.39	1.00			
LC	.54	.54	1.00		
LD	.49	.29	.36	1.00	
Word Attack	.34	.62	.50	.08	1.00

Abbreviations

CA: Chronological Age
GFE: Good Phonetic Equivalent
LC: Letter-Change Condition
LD: Letter-Dot Condition

TABLE 8

CORRELATION MATRIX FOR PERCENT GFE'S IN DISABLED READERS (N=28)

	CA	GFE	LC	LD	Word Attack
CA	1.00				
GFE	.66	1.00			
LC	.69	.68	1.00		
LD	.49	.39	.46	1.00	
Word Attack	.63	.60	.51	.18	1.00

Abbreviations

CA: Chronological Age
GFE: Good Phonetic Equivalent
LC: Letter-Change Condition
LD: Letter-Dot Condition

obtained for LD ($r=.37$, $p<.05$).

To summarize, the results of the regression analyses for the total group of subjects indicated that performance on the Woodcock Word Attack Test was the best predictor of all three Boder and Jarrico criterion measures. Word attack accounted for 60.5% of the variance in Reading Age, 14% of the variance in the Known Correct score and 38% of the variance in GFE. LC accounted for significant variance in Reading Age and GFE. There was a significant correlation between LD and GFE, but LD did not emerge as a significant predictor in any of the regression analyses. The results obtained in the analyses of the disabled readers were generally consistent with the total group analysis.

F. High vs. Low GFE

To contrast the role of phonics and visual memory factors in the production of GFE's, the examinees were divided into two groups: those who produced more than 50% GFE's (the High GFE group) and those who produced 50% or fewer GFE's (the Low GFE group). In the total sample of 48 subjects there were 17 in the low GFE group (11 disabled and 6 normals) and 31 in the high GFE group (17 disabled and 13 normals). The percent GFE's in the High GFE group (mean=82.58, s.d.=13.15) was significantly higher than the Low GFE (mean=34.11, s.d.=18.39) group (F 1,46=111.8, $p<.0001$). The High GFE group was slightly but not significantly older (F 1,46=3.6, $p>.05$) than the Low GFE group (mean age High GFE=10.5 years, mean age Low GFE group=9.4 years). Reading ability as indicated by RQ did not differ between groups (F 1,46=1.2, $p>.1$), although the mean Reading Age was significantly higher in the High GFE (10.3, s.d.=2.6) than the Low GFE (8.7, s.d.=37.19) group (F 1,46=4.1, $p<.05$). The Word Attack score of the High GFE group was significantly higher (mean age score= 10.3 years than the Low GFE group (mean age score= 8.2, F 1,47=10.8, $p<.01$). The groups also differed when Word Attack was expressed as:

Word Attack age score - C.A.

The High GFE group was slightly above C.A. (mean discrepancy from C.A.= .8 year). The Low GFE group was 1.24 years below C.A. This difference was also found to be statistically reliable (F 1,47=5.04, $p<.03$). The groups did not differ with respect to the LD measure (F 1,47=.6, n.s.), but they did for the LC measure (F 1,47=12.1, $p<.01$). The High GFE group recalled significantly more letters (86%) than the Low GFE group (70%).

Next, a regression analysis was conducted in which age, word attack, and the LC and LD conditions of the letter sequencing task were used as predictors, and GFE's was the dependent variable. This analysis was conducted separately for the High GFE and Low GFE group.

First, for the High GFE group the regression analysis indicated that only word attack accounted for a significant (34%) portion of the variance (F 1,30=15.81) in the GFE scores. The correlation matrix is given in Table 9. It shows that only Word Attack was strongly related (r=.587) to GFE. Correlations with GFE for LC (r=.157) and LD (r=.016) were considerably smaller.

For the Low GFE group only the LD condition of the letter sequencing task accounted for a significant portion (61%) of the variance (F 1,15=24.23). The correlation matrix given in Table 10 indicates that there were significant correlations with GFE for LC (r=.504), Word Attack (r=.513), and C.A. (r=.517). The correlation between LD and GFE was much higher (r=.786). The fact that the regression analysis indicated that only LD significantly predicted GFE suggests that there was considerable overlap between C.A., Word Attack, LC and LD.

To summarize, this analysis indicated that relative to the Low GFE group, the High GFE group had superior Word Attack scores, even when there was an adjustment for differences in age level between the groups, and recalled more letters during the letter sequencing task. However, performance in the LD condition did not differentiate the groups. The outcome of the regression analysis indicated that GFE was significantly related to performance on the Word Attack test for the High GFE group, whereas it was

TABLE 9

CORRELATION MATRIX FOR THE HIGH GFE GROUP

	CA	GFE	LC	LD	Word Attack
CA	1.00				
GFE	.13	1.00			
LC	.37	.15	1.00		
LD	.41	.02	.23	1.00	
Word Attack	.17	.58	.32	- .05	1.00

Abbreviations

CA: Chronological Age
GFE: Good Phonetic Equivalent
LC: Letter-Change Condition
LD: Letter-Dot Condition

TABLE 10

CORRELATION MATRIX FOR THE LOW GFE GROUP

	CA	GFE	LC	LD	Word Attack
CA	1.00				
GFE	.52	1.00			
LC	.62	.50	1.00		
LD	.59	.78	.48	1.00	
Word Attack	.59	.51	.70	.31	1.00

Abbreviations

CA: Chronological Age
GFE: Good Phonetic Equivalent
LC: Letter-Change Condition
LD: Letter-Dot Condition

related to performance in the LD condition in the Low GFE group.

G. Developmental Analysis

In this analysis age-related changes were investigated in the two Boder and Jarrico criterion measures which are not adjusted for age: Known Correct and GFE. Correlational analysis for the total group indicated that there was a significant relationship between C.A. and GFE (r=.39, p<.05), but not between C.A. and Known Correct (r=.18, p>.05). For the disabled readers the correlation between C.A. and GFE was considerably higher r=.661 p<.01), but that between Known Correct and C.A. was not (r=.14, p>.05). Since there was no significant relationship between C.A. and Known Correct, it was not included in subsequent analyses.

Next, a between age group comparison was conducted by dividing by means of a median split the total sample of examinees into young and old age groups. Analysis of variance indicated that the groups differed significantly (F 1,46=6.99,p<.01) with respect to percent GFE's (young mean=54.5%, s.d.=31.4; old mean 74.6%, s.d.=20.8). Even though the older age group produced significantly more GFE's, RQ was significantly smaller (F 1,46=4.14, p<.05) (young mean=105.72, s.d.=30.7; old mean=90.15, s.d.=22.1). The Reading Age of the young subjects was 8.74 years, which was slightly above their mean chronological age (8.33

years). The mean Reading Age of the older group was 10.49 years which was nearly 1 1/2 years below chronological age.

In the preceding analysis the significant difference in RQ suggested that the younger readers were not as disabled as the older readers. In order to obtain two groups which were matched more evenly with respect to RQ, in the next analysis only disabled readers with RQ less than 90 were included. A median split on age for this group yielded 11 subjects in the young group (mean age=8.5 years, s.d.=1.54) and 11 in the older group (mean age=12.1 years, s.d.=.875). These two groups did not differ with respect to RQ (young mean=73.09, s.d.=8.4; old mean=73.5, s.d.=14.2). The mean Reading Age of the young group was 6.06 years, whereas that of the older group was 8.9 years. Percent GFE's differed (F 1,20=10.6, p<.01): The young age group produced significantly fewer of them (mean=41.8%, s.d.=31.2), than the older group (mean= 77%, s.d.=17.9%).

To summarize, the developmental analysis indicated that older subjects tended to produce more GFE's than younger subjects. In the analysis of the total group of 48 subjects, there was also a significant difference in RQ between the age groups, suggesting that the older readers were less skilled. In a subsequent analysis of disabled readers only, it was found that the older age group produced significantly more GFE's, but there was no between-group difference in RQ.

IV. Discussion

Boder and Jarrico (1982) have developed a method of subtyping disabled readers which is based on patterns of performance in reading and spelling. In this method disabled readers are grouped into subtypes on the basis of three measures: RQ, percent Known Correct and percent GFE. Boder and Jarrico suggest that RQ provides an index of the ability to read words as whole patterns, Known Correct is the ability to revisualize words in the sight vocabulary, and GFE is a measure of phonic word analysis skills. The purpose of the present study was to examine their conclusions regarding the cognitive significance of these measures.

A. Total Group Analysis

1. Known Correct and Reading Quotient

According to Boder and Jarrico, the tasks from which RQ and Known Correct are derived depend heavily on visual memory skills. It was, therefore, hypothesized that significant variance in RQ and Known Correct scores should be predicted by performance on a visual memory task. In the present study the LD condition of the letter sequencing memory task was the measure of visual memory. Reading Age was used instead of RQ, because some of the other measures in the regression equation were also age scores. In the analyses of both the total sample of normal plus disabled readers, and the disabled readers alone, it was found that visual memory performance did not account for a significant portion of the variance in RQ or Known Correct. Instead, Word Attack and the LC condition of the letter sequencing memory task were the best predictors of both measures. Thus, the present data suggest that the Boder and Jarrico are not sensitive to visual-spatial abilities, at least as measured by the positional memory task used in the present work.

2. Percent GFE

Boder and Jarrico suggest that GFE is a measure of phonic word analysis skill. It was, therefore, predicted that Word Attack and/or LC condition of the letter sequencing task would be the best predictor of GFE. This prediction was verified both for the total sample and for the sample of disabled readers. Previous studies (Ginn, 1979; Malatesha, 1981) have indicated a verbal processing deficit in those readers who produce few GFE's (dysphonetics). The results of the present study suggest that there is a strong phonic analysis component in percent GFE's, and that the verbal deficit inferred from previous work may be related to difficulties in phonic analysis.

Since the two measures associated with phonic analysis (Word Attack and LC) were the best predictors of Reading Age, GFE and Known Correct, does this mean that all three of the Boder and Jarrico criterion measures relate to a single cognitive process? There are two reasons to reject this conclusion at the present time. First, the Word Attack and LC accounted for much less variance in Known Correct than for Reading Age or GFE. Second, the correlations among the Boder and Jarrico criterion measures varied considerably: The correlation between Reading Age and GFE was .52, whereas that between Reading Age and Known Correct (r=.33) and GFE and Known Correct (r=.29) were much smaller. Even though all three correlations were statistically significant, there is still considerable unexplained variance. However, it is clear from these data that there was considerably more overlap between Reading Age and GFE's than there was for the other two comparisons.

There are two cautions which should be kept in mind when interpreting the present data. First, the conclusions made are limited by the fact that only one measure of spatial ability was used. It is possible that if another such measure had been used, the role of spatial factors in the Boder and Jarrico subtyping procedure would have emerged. It can be said, however, that the present data are supportive of a growing body of evidence (Ginn, 1979; Dalby and Gibson, 1981, but see Aaron, 1978 for an exception) which have failed to demonstrate a spatial deficit in any of the Boder subtypes. Second, even though it was found to be the best predictor in the regression analyses, it must not be assumed that Word Attack skills are causally related to any of the Boder and Jarrico criterion measures. In fact, it may be that there are other factors which are causal with respect to Word Attack skills and performance on the Boder and Jarrico criterion tasks. For example, good readers may do well on the sight word reading test, not because it necessitates the use of phonic analysis, but simply because good readers are more familiar with the words and can access them more rapidly than poor readers. Good readers also have better phonic skills than poor readers, but this may be only incidentally related to their superior performance on the sight word reading test.

B. Is the Cognitive Significance of the Boder and Jarrico Criterion Measures Dependent on the Skills of the Individual Reader?

This question was investigated in order to determine if examinees used different strategies in performing the Boder and Jarrico criterion tasks depending on their skill levels. The focus of attention in addressing this issue was the GFE measure, since this is the most important measure in differentiating the subtypes. Skill level was varied by means of post hoc division of subjects into those who produced more than 50% GFE's (The High GFE group) and those who produced 50% or fewer GFE's (The Low GFE group). Two hypotheses were contrasted. The first hypothesis was based on the assumption that all readers, regardless of skill level, would take basically the same approach to this task. Since the outcome measure was concerned with the production of phonetic equivalents, it was assumed that the level of performance would be largely a function of knowledge of phonics. Under this hypothesis, it was predicted that Word Attack and LC would predict GFE in both the High and Low GFE groups. The alternative hypothesis was that examinees who produced relatively few GFE's might be using an inefficient strategy such as visual memory. This hypothesis predicted that LC and Word Attack would be significantly related to GFE's in the High GFE group, whereas performance in the LD condition would predict GFE's in the Low GFE group. The results of the regression analysis supported the second hypothesis. Word Attack and LC were the best predictors of GFE's in the High GFE Group, while LD was the best in the Low GFE group.

These findings indicate that for subjects who produce few GFE's, most of the variance in GFE production can be explained in terms of visual-spatial ability, whereas for those who produce more than 50% GFE's, the variance in GFE production can be explained in terms of phonic skills. One interpretation of this finding is that the strategy applied to this task may depend on the skill level of the examinee. Those with strong phonics may be using phonics analysis, whereas those with poor phonics may rely more on visual-memory.

There are alternative explanations which cannot be ruled out, because the existence of the strong correlation does not imply a causal relationship between the two variables. There could be a third variable at the root of the correlations which were obtained; e.g., in the Low GFE group, those who maintained a high level of performance in the LD condition may have also been those with high I.Q.'s. Therefore, it may have been the high I.Q and not spatial ability which was responsible for the correlation between LD and GFE. However, this explanation does not account for the absence of such a significant correlation between LD and GFE in the High GFE group.

C. Do the Boder and Jarrico Criterion Measures Need to be Age- Adjusted?

The analysis was concerned with the possibility of an age-related bias in the classification of examinees into subtyping categories. The focus of attention was percent GFE's, since this is the measure which is used to distinguish dyseidetics and dysphonetics. It was hypothesized that with increasing age children become more familiar with phonics, and this would tend to increase the GFE score. Presumably, this could occur in children who had made virtually no progress in reading relative to their peers.

There were several sources of support for this hypothesis. First, significant correlations were obtained between age and GFE in both the total sample and in the disabled readers. Also, a median split of the subjects into age groups indicated that there were significantly more GFE's in the older age group. Again, this occurred in the analysis of the total sample and of the disabled readers also. In the total sample, RQ was significantly lower in the older readers. Even so, the older age group produced more GFE's. In the analysis of the disabled readers, there was no difference in RQ between the young and old age groups, but the older group produced significantly more GFE's. Both findings indicate that more GFE's are produced in older readers, even if the comparison groups do not differ in the degree of reading disability. This suggests that an older reader would have a greater likelihood of being classified as dyseidetic. This conceptualization may explain Paul's (1981) seemingly anomalous finding that most of her adolescent disabled readers were dyseidetic. It suggests that a greater proportion of her adolescent dyseidetics may have been classfied dysphonetic had they been tested a few years earlier. This could be demonstrated more conclusively by repeatedly testing a group of disabled readers once per year from ages 8 to 12. It would be predicted that initially most of the readers would be dysphonetic, while in later assessments, a greater proportion would be classified dyseidetic.

One could also explain the present results by assuming that different populations of readers were represented in the young and old age groups. For example, the age-related increase in GFE's could occur if most older readers were dyseidetic while most young readers were dysphonetic. However, this seems unlikely since in the analysis of the total group, the younger readers had superior Word Attack skill relative to age level than the older readers. Therefore, it is more likely that there were more dysphonetics in the older age group.

D. Remedial Implications of the Data.

As was noted in the Introduction, the unique feature of the Boder and Jarrico method is that it is based on measures of reading and spelling only. It represents a relatively simple set of procedures which can be easily applied in the clinical setting. Indeed, it would greatly enhance the available battery of clinical assessment techniques if such a test were available to provide information on the cognitive deficits related to reading. Such information could be extremely valuable in planning a appropriate remedial program.

The data from the present study and previous research suggest that the strong feature of the test is in detecting reading problems related to a deficiency in phonic analysis skills. The GFE score, by itself, provides a reasonably good estimate of an examinees knowledge of phonics.

However, the relationship between age and GFE obtained in the present study suggests that the GFE measure is not an indicator of a cognitive deficit underlying phonic analysis. Instead, the GFE measure appears to be primarily an indicator of phonics achievement.

There is little indication that the test can be used to detect reading problems related to visual processing skills. Without this capability, it should not be called a subtyping methodology, and it would lose much of its potential for guiding the remedial process.

It should be noted that the test may have potential as a sight word reading test. It contains graded word lists, and it has considerable advantage over the WRAT reading and spelling tests, since it enables one to infer the examinees knowledge of phonics from the pattern of spelling errors.

E. Suggested Modifications of the Boder and Jarrico Subtyping Procedure

1. The Description of the Subtypes

Boder and Jarrico describe each of the two fundamental subtypes, dysphonetics and dyseidetics, in terms of a deficit in a single sensory modality. Dysphonetics alledgedly have a deficit in the auditory-analytic function; dyseidetics in the visual-gestalt function. In contrast, the analysis of the Boder and Jarrico criterion tasks which has been presented in this study has emphasized the cross modal nature of these tasks. For example, in reading the list of sight words, the stimulus material is presented visually and the examinee must respond orally. In the two spelling tasks from which the Known Correct and GFE scores are derived, auditory information is presented and the examinee must give a written response. From such tasks, it is extremely difficult to infer that the deficit occurs in a particular modality. If an examinee produces relatively few GFE's, this could occur because of a difficulty in performing the initial auditory analysis of the word into its constituent phonemes or because of an inability to translate the output of the auditory analysis into a graphic image to be used in writing. For this reason it would seem much more reasonable to discuss the results in terms of information processing pathways. This theoretical framework has been used by Baron and colleagues (Baron and Trieman, 1979; Baron, 1979) to describe two different approaches to extracting meaning from printed words. The direct method refers to an information processing pathway from print to meaning. In this case the word is not translated into sound at all, but rather the meaning of the word is accessed directly from the visual image of the word. This pathway is not directly relevant to the Boder and Jarrico method. The indirect route is one in which the visual stimulus is first converted to sound before the meaning is ascertained. In this model they indicate two paths to sound, one which occurs by means of word specific associations and one which takes place by means of correspondence rules. These two paths to sound correspond to the whole word and phonic analysis methods of reading described by Boder and Jarrico. Given the measures used by Boder and Jarrico, it seems more reasonable to describe the reading deficits in terms of these pathways, rather than as deficits restricted to a specific sensory modality.

2. Making Inferences about Visual-Gestalt Processing

It has been repeatedly emphasized that there is little evidence to suggest that the Boder and Jarrico methodology can provide an index of visual-gestalt processing ability. However, there are two modifications of the procedures which might improve the likelihood of extracting this information. First, one of the assumptions of the Boder and Jarrico methdology is that examinees read the words in the sight word list as whole patterns, rather than using phonetic correspondence rules. Boder and Jarrico maintain that a whole word strategy must be used because examinees are given only one second to read the word, and there is insufficient time to perform phonic analysis. While this is not an unreasonable assumption, there is no guarantee that examinees cannot perform some type of phonic analysis in one second.

To examine this issue one could present the words in the sight lists across a range of very brief exposure durations on the order of 50 to 500 msec. At each exposure duration, correlations could be computed between visual memory performance and the number of words read correctly. The very brief presentations used in such an experiment might force a examinees to employ a visual strategy.

Second, an index of visual processing ability might be obtained by examining the discrepancy between the number of words read timed (within one second of presentation) and untimed (within 5 seconds of presentation). If far more words were read untimed than timed, this might be an indication of inadequate visual memory skills. This could be verified by computing correlations between this discrepancy score (words read untimed - words read timed) and a measure of visual-spatial skills. Alternatively, if nearly all the words read were timed, it might suggest that the examinee has access only to visual memory and cannot use phonic analysis.

V. Summary

The results of the present study may be summarized in terms of the following points:

1. The three criterion measures utilized in the Boder and Jarrico test (RQ, GFE, and Known Correct) are most closely related to phonic analysis skill.

2. There is little indication that the procedures utilized in the Boder and Jarrico subtyping methodology are sensitive to visual-spatial skills. Without this capability, it ceases to be a subtyping methodology, and is of limited use as the basis for planning a remedial program.

3. The analysis of the High and Low GFE groups suggest that different strategies may be applied to the Boder and Jarrico criterion tasks. GFE production was a function of phonic skill in the High GFE group and of visual-spatial ability in the Low GFE group.

4. The age-related increase in GFE's suggests that young subjects are more likely to be classified as dysphonetic; older subjects as dyseidetic.

5. The test must be interpreted with great caution at the present time. As suggested by Boder and Jarrico, it should be used only in conjunction with other assessment information.

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Glossary

Cerebral Lateralization: This term refers to the view that there are asymmetries in the organization of the brain. For example, in most individuals language functions appear to be controlled by the left cerebral hemisphere, whereas visual-spatial functions are controlled by the right cerebral hemisphere.

Dyseidetic: According to Boder and Jarrico, this is a reading disability related to a deficit in visual-gestalt processing. This deficit manifests itself as an inability to respond to words as whole patterns. In order to read a word the dyseidetic must analyze a word into its constituent phonemes.

Dysphonetic: According to Boder Jarrico, this refers to a reading disability related to a deficit in the verbal-analytic function. This deficit manifests itself as an inability to perform phonic analysis.

Regression Analysis: A statistical method in which the relationship between several independent variables or predictors and a single dependent variable is examined. In regression analysis a correlation is computed between a composite variable made up of the set of predictors and the dependent variable. In addition, this method of analysis allows one to assess the independent contribution of each of the predictors to the regression equation.

Visual-Gestalt: The tendency to perceive visual configurations in terms of the overall relationships between parts, rather than focusing on the individual elements. Boder and Jarrico use this term to refer to a reading strategy in which a word is read as a single perceptual configuration. It may be contrasted with the analytic strategy which involves breaking the word down into components. Two of the more common analytic strategies would be syllabication, and phonetic analysis.

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